Iron-rich carbonates as the potential source of evolved CO_2 detected by the Sample Analysis at Mars (SAM) instrument in Gale Crater.

Sutter, B. E. Heil, E.B. Rampe, R.V. Morris, D.W. Ming, P.D. Archer, J.L. Eigenbrode, H.B. Franz, D.P. Glavin, A.C. McAdam, R. Navarro-González, P.B. Niles, P.R. Mahaffy, J.C. Stern, S. Mertzman and the MSL science team

The Sample Analysis at Mars (SAM) instrument detected at least 4 distinct CO_2 release during the pyrolysis of a sample scooped from the Rocknest (RN) eolian deposit. The highest peak CO_2 release temperature (478-502°C) has been attributed to either a Fe-rich carbonate or nano-phase Mg-carbonate. The objective of this experimental study was to evaluate the thermal evolved gas analysis (T/EGA) characteristics of a series of terrestrial Fe-rich carbonates under analog SAM operating conditions to compare with the RN CO2 releases. Natural Fe-rich carbonates (<53µm) with varying Fe amounts ($Fe_{0.66}X_{0.34}$- to $Fe_{0.99}X_{0.01}$-CO_3, where X refers to Mg and/or Mn) were selected for T/EGA. The carbonates were heated from 25 to 715°C (35°C min^{-1}) and evolved CO_2 was measured as a function of temperature. The highest Fe containing carbonates (e.g., $Fe_{0.99}X_{0.01}$-CO_3) yielded CO_2 peak temperatures between 466-487°C, which is consistent with the high temperature RN CO_2 release. The lower Fe-bearing carbonates (e.g., $Fe_{0.66}X_{0.34}CO_3$) did not have peak CO_2 release temperatures that matched the RN peak CO_2 temperatures; however, their entire CO_2 releases did occur within RN temperature range of the high temperature CO_2 release. Results from this laboratory analog analysis demonstrate that the high temperature RN CO_2 release is consistent with Fe-rich carbonate (~0.7 to 1 wt.% $FeCO_3$). The similar RN geochemistry with other materials in Gale Crater and elsewhere on Mars (e.g., Gusev Crater, Meridiani) suggests that up to 1 wt. % Fe-rich carbonate may occur throughout the Gale Crater region and could be widespread on Mars. The Rocknest Fe-carbonate may have formed from the interaction of reduced Fe phases (e.g., Fe^{2+} bearing olivine) with atmospheric CO_2 and transient water. Alternatively, the Rocknest Fe-carbonate could be derived by eolian processes that have eroded distally exposed deep crustal material that possesses Fe-carbonate that may have formed through metamorphic and/or metasomatic processes.